LXXI. *A Letter from* John Canton, *M. A. and F. R. S. to* Benjamin Franklin, *LL. D. and F. R. S. containing ſome Remarks on Mr.* Delaval's *Electrical Experiments.*

Dear Sir,

Read Feb. 4, 1762. MR. Delaval, in his curious electrical experiments, found that Portland ſtone, common tobacco-pipe, &c. would readily conduct the electrical fluid, when very hot, or when quite cold; but were non-conductors in an intermediate ſtate. As no one, that I know of, has yet attempted to account for this, I ſhall ſubmit the following ſolution to your judgment.

The ſtone, tobacco-pipe, wood, &c. I apprehend, conduct when cold, by the moiſture they contain in that ſtate; when their moiſture is evaporated by heat, they become non-conductors; and when they are made very hot, the hot air at, or near their ſurfaces, will conduct, and the bodies appear to be conductors again.

To prove that hot air will conduct the electrical fluid, let the end of a poker, when red-hot, be brought, but for a moment, within three or four inches of a ſmall electrified body, and its electrical power will be almoſt, if not entirely deſtroyed.

And if excited amber, &c. be held within an inch of the flame of a candle, it will loſe its elec-

tricity before it has acquired a ſenſible degree of heat (1).

That glaſs is a conductor in damp weather, on account of the moiſture on its ſurface, is well known; as alſo, that warming it a little will render it a non-conductor; and that a great degree of heat will make it ſeem to be a conductor again. Now tobacco-pipe, wood, &c. will not only attract the moiſture of the air to their ſurfaces, but will alſo abſorb it; whence they are conductors in dry weather; and require more heat than glaſs, as well as a longer continuance in it, to render them non-conductors. It is remarkable, that tobacco-pipe, after it begins to cool, will become a conductor again, ſooner than moſt other ſubſtances, and much ſooner than wood. The cauſe of this appears to me, to be the tobacco-pipe's abſorbing the moiſture of the air faſter than moſt other

(1) I have obſerved alſo, that the Tourmalin, Brazil Topaz, and Brazil Emerald, will give much ſtronger ſigns of electricity while cooling, after they have been held about a minute within two inches of an almoſt ſurrounding fire, where the air is a conductor, than they ever will after heating them in boiling water. And if both ſides of either of thoſe ſtones be equally heated, but in a leſs degree than will make the ſurrounding air a conductor, the electricity of each ſide, whether *plus* or *minus*, will continue ſo, all the time the ſtone is both heating and cooling; but will increaſe while it is heating, and decreaſe while it is cooling. Whereas, if the heat be ſufficient to make the ſurrounding air conduct the electric fluid from the poſitive ſide of the ſtone to the negative ſide of it, while heating; the electricity of each ſide will increaſe, while the ſtone is cooling, and be contrary to what it was, while the ſtone was heating. See the Philoſophical Tranſactions, Vol. LI. p. 403 and 404.

ſubſtances,

ſubſtances, and much faſter than wood: for the ſurfaces of tobacco-pipe and wood being wetted, the ſurface of the wood will continue wet much longer than the ſurface of the tobacco-pipe.

That tobacco-pipe does not become a non-conductor by a particular degree of heat, without evaporating its moiſture, is evident, from the following experiments. If three or four inches of one end of a tobacco-pipe, of more that a foot in length, be made red-hot, without ſenſibly heating the other end; this pipe will prove a ready conductor, through the hot air ſurrounding one part of it, and the moiſture contained in the other; although ſome part of it muſt have the degree of heat of a non-conductor. But if the whole pipe be made red-hot, and ſuffered to cool, till it has only ſuperficial moiſture enough to make it a good conductor; and then three or four inches of one end be again made red-hot, it will become a non-conductor. And if a nail be placed at, or near each end of a longiſh ſolid piece of any of the abſorbent bodies above-mentioned, ſo that the point of each nail may be about half the thickneſs of the body, within its ſurface; this body, by heat, may be made a non-conductor externally, or ſuperficially, while it remains a good conductor internally: for the electric fluid will paſs readily from one nail to the other, through the middle of the body, when it will not paſs on its ſurface; and even when the internal parts of the body are in an equal degree of heat with the external; as they muſt ſoon be, after it begins to cool. But if the ſame body be expoſed, for a ſhort time, to a greater degree of heat than before; or if it be

kept

kept longer in the ſame heat, it will become a non-conductor entirely.

In making the above experiments, I uſed the little electrometer, which I have deſcribed in the forty-eighth volume of the Philoſophical Tranſactions, p. 783, and ſupported it by ſealing-wax, or warm glaſs.

I well remember your acquainting me, that Mr. Delaval did not approve of the above manner of accounting for his experiment on tobacco-pipe, ſoon after you related it to him, which was ſome time laſt ſummer: but as it ſtill appears ſatisfactory to me, notwithſtanding what that gentleman has lately offered againſt it (2), your laying it before the Royal Society will oblige,

Dear Sir,

Your moſt obedient

and moſt humble ſervant,

Spital-Square,
January 21, 1762.

John Canton.

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(2) See a Letter from Mr. Delaval to Mr. Wilſon, in the firſt part of the fifty-ſecond volume of the Philoſophical Tranſactions.

P. S.

P. S. Having formerly obſerved, that the friction between Mercury and Glaſs *in vacuo*, would not only produce the light of electricity, as in the luminous barometer, or within an evacuated glaſs ball, but would alſo electrify the glaſs on the outſide; I immerged a piece of dry Glaſs in a baſin of Mercury, and found, that by taking it out, the Mercury was electrified *minus*, and the Glaſs electrified *plus*, to a conſiderable degree. I found alſo, that Amber, Sealing-wax, and Iſland Cryſtal, when taken out of Mercury, were all electrified *poſitively* (3). How does it then appear, that the electricity, which was obſerved upon rubbing the laſt mentioned ſubſtance, after it was taken out of Mercury ſurrounded by Ice, was owing to *cold*, and not to the *friction* between it and the Mercury, in taking it out? Iſland Cryſtal, when *warm*, is a non-conductor; and all non-conductors may be excited with proper rubbers.

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(3) A ſmall quantity of an *amalgama*, or mixture, of Mercury and Tin, with a very little Chalk or Whiting, being rubbed on the cuſhion of a globe, or on the oiled ſilk-rubber of a tube, will excite the globe or tube to a great degree, with very little friction; eſpecially if the rubbers be made more damp, or dry, as occaſion may require.